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ABSTRACT

This case study is one of a series focusing on computers as everyday learning and teaching tools which is addressed to administrators, teachers, staff, and students who wish to plan or improve the uses of computers at their own institutions. Following a brief description of the purpose and selection of cases for the overall study, the report profiles academic computing at Worcester Polytechnic Institute (WPI), a private, technical college in Worcester, Massachusetts, with 2500 undergraduate and 600 graduate students; degree programs in scientific, engineering, and interdisciplinary subject areas; and a project-oriented curriculum. The report summarizes the computing history at WPI since 1960 and describes the Worcester Area College Computation Center which operates central computers for academic and administrative uses and provides such supporting services as programming, documentation, and consultation. Other sections report on student access to computing, facilities, costs, student accomplishments, applications, computer literacy, computer science curricula, outreach, and plans and goals. Advice is given on computer center management and computer use policies. A list of contacts, nine references, and a list of the case study and exemplar institutions of the overall study are provided. (LMM)

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Academic Computing at Worcester Polytechnic Institute

A Case Study

Beverly Hunter

1978

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Foreword

This book was prepared by the Human Resources Research Organization and supported by the National Science Foundation Science Education Directorate, Grant Number SED-76-15399. Dr. Robert J. Seidel, Director of HumRRO's Eastern Division in Alexandria, Virginia, is Principal Investigator for the project. Ms. Beverly Hunter is co-Principal Investigator. Any opinions, findings, and conclusions expressed in this book are those of the authors and do not necessarily reflect the views of the National Science Foundation.

James J. Jackson, Director of the Worcester Area College Computation Center, provided the information for this case study.

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Academic Computing at Worcester Polytechnic Institute

A Case Study

Purpose

This book is one in a series of twenty-one Case Studies of Academic Computing. The Case Studies focus on the ways in which computers have come to be an everyday tool and companion to students and teachers for the purpose of learning and teaching. The Case Studies are addressed to administrators, teachers, staff and students who wish to plan, extend, or improve the uses of computers at their own institutions. You should find the Case Studies helpful in performing one or more of the following kinds of activities.

1. *Assessing the extent and nature of instructional computing at your own institution, by comparison with the Case Institutions.*

We selected a range of different sizes and kinds of institutions so that you could find one that most closely resembles your own. The Case Institutions include secondary schools, public school districts, community colleges, colleges, and universities in most regions of the continental United States.

2. *Organizing and staffing your computer center to provide improved support for instructional computing activities.*

The Case Studies highlight those aspects of organization and staffing that appear to be most significant in encouraging beneficial uses of computers for learning and teaching.

3. *Making computer resources more accessible to students.*

The Case Studies identify policies, procedures, documentation, hardware, software, and courses that facilitate student use of computing.

4. *Establishing realistic educational goals for instructional computing.*

The sections on Student Accomplishments provide ideas as to the kinds of achievements students attained with the aid of computers.

5. *Extending computer applications in particular courses and disciplines.*

Information is available in Case Books and from the contact persons listed at the back of the book concerning the kinds of computer applications used in the various academic disciplines and courses.

6. *Raising the general level of computer literacy on campus.*

The section on Computer Literacy describes goals and programs aimed at educating students and faculty regarding computer uses and the impact of computers on society.

7. *Establishing or improving a computer science curriculum.*

Most of the Case Institutions have a formal program designed to train students in computer science and/or data processing.

8. *Sharing your facilities, expertise, or curricular materials with your community or other institutions.*

The section on Outreach describes the ways the Case Institution makes an impact on the world around it with regard to instructional computing.

9. *Preparing a Five Year Plan for academic computing at your institution.*

The organization of the Case Books might be a useful framework for presenting your own Five Year Plan. Also, most of the Case Institutions have their own Plans from which you may draw ideas.

Selection of Cases

Case Institutions were selected through a four-stage procedure. First, we conducted a systematic search for institutions that are regarded as outstanding in their uses of computers for learning and teaching. Invitations were mailed to seven thousand educators and technologists who belong to professional organizations concerned with educational computing. These individuals were invited to nominate one or more educational institutions that they regard as outstanding. Nominators were asked to give specific reasons why the school should be considered, given the objectives of our study.

Over 500 individuals responded, nominating 370 institutions that met our criteria.[1] Eligible institutions included individual elementary and secondary schools, public school districts, community colleges, colleges, and universities, and public access institutions such as museums.

Second, we contacted, at each nominated institution, an individual who has a purview of instructional computing activities. In many cases, this individual is the Director of the Computing Center or a Coordinator of Instructional Computing. The nominated institutions were happy to participate, and provided information about their activities via a telephone interview with a member of our staff. The product of this stage is an Academic Computing Directory, published by HumRRO, that gives brief information on the reasons for nomination, enrollment, typical computer applications, make and model of main computer(s), number of terminals on campus, and persons to contact.

Third, the nominees were invited to respond to one or more of a series of open-ended questionnaires corresponding to the following Categories of Excellence:

1. Institutional Commitment to Instructional Computing
2. Student Accomplishments
3. Institution Productivity
4. Spectrum of Applications
5. Computer Literacy
6. Computer Science and/or Data Processing Programs
7. Outreach
8. Model

[1] Projects, consortia, timesharing companies were not eligible.

These questionnaires were quite lengthy and required considerable work on the part of the respondents. By completing one or more of the questionnaires, the respondents demonstrated their willingness and ability to share information. Over one hundred of the nominees responded in one or more categories of excellence. HumRRO staff then reviewed all candidate institutions within each Category of Excellence. We selected as Exemplars in each Category those institutions that had provided complete answers and had demonstrated a high commitment to instructional computing. Consulting experts were called upon to review candidates in specific Categories. The product of this third stage is a list of Exemplary Institutions distributed by HumRRO.[1]

Fourth, the Case Institutions were selected from among the Exemplars. The following criterion dimensions were used in selection:

1. High institution commitment to academic computing as demonstrated by the survival of instructional computing over several budget cycles; staff support for instructional computing; reform of curriculum to incorporate computer uses; increases in appropriate computing equipment; incentives to faculty for instructional innovation.

2. High degree of computer literacy among students, faculty and administration, as reflected in student accomplishments, spectrum of applications, and number of computer users on campus.

3. Appropriate response to the Model questionnaire, and usefulness of all questionnaire responses.

[1] A list of the exemplars and twenty-one Case Institutions is provided as Appendix A.

Profile

Worcester Polytechnic Institute is a private technical college funded in 1865 in Worcester, Massachusetts. There are 2500 undergraduate and 600 graduate students.

WPI offers degree programs in scientific, engineering, and interdisciplinary subject areas, with flexibility for students to create their own major programs of study. There are 305 full-time and 59 part-time faculty members.

In 1969, WPI embarked on an ambitious approach to higher education, called the "WPI Plan". The WPI Plan provides the student with every possible resource to enable him to tailor his own education to his special areas of interest. Requirements for graduation under the WPI Plan include a competency examination in the student's major field of study, qualification in a minor field of study, a "Major Qualifying Project" in the major field of study, and an Interactive Qualifying Project in a field relating technology to society. Many courses are in an "Individually Prescribed Instruction" (IPI) format in which students work primarily by themselves from written study guides that state objectives for the course and suggest ways of accomplishing the objectives. Students also spend a large proportion of their time in independent study projects, including their qualifying projects and studying for competency examinations.

Students tend to be independent and self-directed as required by the project oriented curriculum. Because of the emphasis on independent study and projects, and because of the technical and scientific nature of the curricula, students at WPI place heavy reliance upon computer based tools. In a typical academic year, every student will use the computer for some learning purpose.

The tuition is $4000 and total estimated student costs including room, board, books, and expenses, is $6600.

Computing Since the Early 1960's

Since the early 1960's, computing at WPI has continually expanded in quantity and variety of applications, corresponding to the rapid changes in computer technology available to support these applications.

Early 1960's

Computing was concentrated in two areas—Mathematics and Electrical Engineering. An IBM 1620 in the Mathematics Department was available to a limited group of graduate students and faculty.

Two computer-related courses available for senior level undergraduates—numerical methods courses in mathematics and in mechanical engineering. Course content equivalent to a present-day freshman introductory course.

EAI analog computer attached to a DEC PDP-7 digital machine in Electrical Engineering Department used in advanced courses.

1967

Administrative computing done on an IBM 1401.

Academic and administrative computing done under separate management.

NSF grant assisted in acquisition of an IBM 360/40 in place of the 1620 for academic computing.

Worcester Area College Computation Center (WACCC) formed; provided batch computing services to WPI, Clark, Assumption, and Quinsigamond Community College.

New computer's capability enables all WPI students to have access to computing.

1968

Computer Science Department established.

1969

Replacement of IBM 360/40 with an RCA Spectra 70/46 enabled both timesharing and batch applications.

Administrative load on IBM 1401 forced upgrade to a UNIVAC 9300.

1972 DEC PDP-10 acquired for academic timesharing, due to withdrawal of RCA from the computer business and WACCC's need for expansion. Number of terminals on campus doubled, and all students and faculty given their own personal accounts on the computer.

1972 - 1977 Several departments acquire minicomputers for special applications such as the Electrical Engineering Laboratory, nuclear reactor data collection, spectrometer output, Computer Science Laboratory.

RCA Spectra 70/46 replaced by UNIVAC 90/60 for administrative applications.

1978 18 microcomputers, each with a terminal and floppy disk storage, acquired for student use from a computer lending library.

Worcester Area College Computation Center

Academic and administrative computing are managed by the Worcester Area College Computation Center (WACCC). WACCC operates the central computers and provides supporting services including programming, documentation and consultation.

WACCC has a full-time staff of 19, plus several part-time student programmers. One group supports WPI administrative applications, including admissions, financial systems, and registration. Another group supports the same applications for outside colleges. An operations manager spends about half of his time on educational and research services, and he has student programmers to assist users with consultation and programming.

One systems programmer is assigned to each of the central computers, the UNIVAC 90/60 and the DECsystem-10. The systems programmers are also consultants to the users in addition to their system support duties.

A computer advisory committee is composed of one member from each academic department and the Dean of Graduate Studies and Research. This committee meets monthly with the WACCC Director to provide feedback on WACCC's operations and to make suggestions for changes and new projects.

FACULTY SUPPORT

Faculty are supported through programming and consulting assistance provided by WACCC staff. WPI also encourages innovation in teaching by making small grants available through the Ford Venture Fund and WPI's Center for Educational Research and Development. These grants have been used to initiate activity in CAI and the development of common software tools for use in the management of IPI courses.

Student Access to Computing Facilities

COMPUTERS

UNIVAC 90/60 (Batch)
DECsystem-10
DEC PDP-7
EAI 680
Sixteen DEC LSI-11 (Microcomputers for student use)
Four DEC PDP 11/10 (Electrical Engineering Laboratory)
DEC PDP 11/40
DEC PDP 11/35
DEC PDP 8

TERMINALS

WACCC supports nineteen terminals for student use, including hard-copy terminals—the DEC LA36—and video terminals—the ADDS 580. These are distributed in 4 terminal locations on campus:

(1) DANIELS HALL (student dormitory), a 24 hour access area. Two hardcopy and two video terminals.

(2) SALISBURY HALL (centrally located building), access from 8 am to 11 pm. Three hardcopy, four video terminals.

(3) WACCC office area (terminals for student use, not WACCC staff) access from 8 am to 11 pm. Two hardcopy, three video, one braille terminal.

(4) KAVEN HALL (opposite end of campus from DANIELS HALL) access from 8 am to 11 pm. One hardcopy, one video.

In addition to these WACCC supported terminals, there are a large number of departmentally owned dial-up terminals and one high-speed line connected to the Electrical Engineering hybrid complex.

SOFTWARE

The software languages available provide a wide variety of dialects for students. They range from simple computational languages to newer

block structured languages, and include :

FORTRAN (DEC, 2 versions)
FORTRAN (UNIVAC, 2 versions)
COBOL (DEC and UNIVAC)
SNOBOL (DEC, 2 versions)
SNOBOL (UNIVAC)
BASIC (DEC)
PL1 (UNIVAC)
ALGOL (DEC)
BLISS (DEC)
MACRO (DEC)
ASSEMBLER (UNIVAC)
LISP (DEC, 2 versions)
AID (DEC)
FOCAL (DEC)
SAIL (DEC)
FAIL (DEC)
PASCAL (DEC)
SIMULA (DEC)

In addition to these languages, several cross assemblers enable students to develop software for mini and micro computers using the DECsystem.

A variety of applications packages are available such as Integrated Civil Engineering System (ICES); Symbolic Mapping Program (SYMAP); Statistical and Mathematical program libraries; Dartmouth Basic Library, International Mathematical and Statistical Library (IMSL) and many others.

ACCESS POLICIES

Any member of the WPI community, student staff or faculty, may use either of the two WACCC computer facilities (UNIVAC and DEC) as much or as often as he wishes provided he does not jeopardize the rights and privileges of other users or degrade the system performance. If others are waiting for a terminal, a user must limit his connect time to 30 minutes.

Use of system resources for developing or playing of games is strictly controlled. WACCC does not support or encourage use of the computer either in running game programs or for other "non-productive" purposes. (6)

ASSISTANCE

WACCC provides user documentation, newsletters, help files, and other forms of documentation to assist users. WACCC also employs several student programmers on a part-time basis who help users find, write, and debug programs.

USAGE

The DEC timesharing system was used by 1748 different members of the WPI student body and faculty during the 1976-77 academic year. The average connect time per user was 54½ hours, and the average number of jobs per user was 150. These figures are higher by 120 users and 10,000 connect hours over the previous year's usage.

Costs of Computing

Total computing budget, including both administrative and academic computing, is as follows:

1976-77	1977-78	1978-79
$630,000	$650,000	$615,000

Of the total budget for 1978-79, $460,000 is expended for academic computing. The cost components of this total include:

Equipment	$115,000
Terminals	50,000
Software	10,000
Staff	260,000
Other	25,000

The budget is prepared by the Director and approved by the President and the Trustees of the college. All expenditures for computing are paid for by the WPI operating budget.

The cost of computing per student is approximately $200 per year.

Student Accomplishments

In order to complete their degree requirements, students must complete two major projects—the Major Qualifying Project and the Interactive Qualifying Project. Usually three 7-week terms are required to complete each of these projects, and the projects involve a high degree of research and/or practical laboratory work.

The computer becomes a very important part of these projects in many cases. The student may require computer based tools such as SPSS, the International Mathematical and Statistical Package, Biomedical programs, and the like. Or he/she may be developing computer programs to perform special kinds of problem solving.

One example of an Interactive Qualifying Project is "Teaching at Auburn High," by Richard Rupp and Ron Howard. (4) Mr. Howard and Mr. Rupp spent one semester teaching a class of high school students about computing. They created the course content, brought in computer terminals from WPI to use as a laboratory, taught the course, conducted an evaluation of the course, and documented the entire course including handouts, terminal sessions, student reactions, and recommendations for improvement of the course.

A second example of an Interactive Qualifying Project is "Computer Administered Lessons for the Executive Game," by David Kinder. (3) The Executive Game is a computer simulation of a corporation used to help students learn to make decisions on financial and operating functions of the organization. Mr. Kinder developed and programmed computer-assisted instruction lessons to supplement the game. The lessons help student game-players to understand the principles behind the operating of the game; provide strategy hints; tell how to read the game's financial reports; and teach other skills needed in order to play the game in an informed way.

Spectrum of Applications

About half of the academic departments at WPI use computers in some of their courses. The following are examples of courses and applications in these departments.

CIVIL ENGINEERING

In the 1976-77 academic year, 118 students in CE courses used 2467 hours of connect time and ran 5675 jobs on the timesharing computer The following courses use the computer:

Introduction to Analysis and Design I
Integrated Civil Engineering System (ICES)
Matrix Computer Analysis of Structures I and II
Design of Reinforced Concrete Structural Systems
Bridging Systems Design

In a typical application, students learn to use the Integrated Civil Engineering System (ICES), to solve civil engineering problems in construction surveying, transportation, and structural analysis and design.

CHEMISTRY

In 1976-77, 29 students in chemistry courses used 654 hours of timesharing connect time and ran 1508 jobs. Courses in Chemistry I, II, and III used the computer. Typical use involves students checking laboratory work and doing calculations using programs written by the Chemistry faculty.

CHEMICAL ENGINEERING

In 1976-77, 110 students used 2578 hours of timesharing connect time and ran 7006 jobs. Courses using computing include Industrial Chemical Calculations and Chemical Engineering Design.

COMPUTER SCIENCE

In 1976-77, 149 students in Computer Science courses used 26,096 hours of timesharing connect time, and ran 84,588 jobs. Courses are listed in the Computer Science section.

ELECTRICAL ENGINEERING

In 1976-77, 243 students in Electrical Engineering courses used 88,042 connect hours and ran 31,838 jobs on the timesharing system. Courses using the computer included:

Electronic Logic Circuits
Introduction to Analog/Hybrid Computer Programming
Digital Computer Organization

With the use of the EAI 630/PDP-7 hybrid machine, the student learns how to relate differential equations to the behavior of physical problems.

MATHEMATICS

29 students used 859 connect hours and ran 2690 jobs. Courses using the computer include:

Numerical Solutions of Differential Equations
Introduction to Numerical Analysis
Operations Research
Mathematical Programming

MECHANICAL ENGINEERING

209 students in Mechanical Engineering courses used 48,813 connect hours and ran 14,710 jobs, in 1976-77. Courses include:

Kinematics of Mechanisms
Dynamics of Mechanisms and Machines

Design of Machine Elements
Introduction to Optimum Design
Power Systems Analysis
Computer Methods in Mechanics

In Dynamics of Mechanisms and Machines, the computer is used as a tool in solving mathematical and graphical problems of forces in relation to mechanisms in motion.

In IPI courses, the written instructional material leads the student to an understanding of the principles involved in the subject matter, and acquaints him with the packaged program which can solve part or all of the problem. The student then uses the computer to complete problems provided in the literature.

There are several applications using graphic outputs. One of them uses a plotter or a video screen to draw molecular structures. Most graphic output is simply 2 or 3 dimension function plotting as auxiliary output of numerical analysis programs.

Computer Literacy

The achievement of computer literacy is a major goal of the Computer Science program at WPI. The Computer Science program provides all undergraduates with the requisite knowledge, skills, and understanding of computers, computing, and their uses in society.

In addition to the regular computer science courses, colloquia and short courses are offered to students and faculty as needed. For example, in 1976 the Electrical Engineering Department offered a three week course on the LSI 11. Every January during Intersession a variety of three and four day courses are offered on topics in computing.

Computer Science at WPI is interested in the social and human implications of computing; the question of how a system should be designed is preceded by considerations of should it be designed at all and if it is designed what are the consequences. These considerations are integrated into the entire program and are specifically considered in the course on Social Implications of Information Processing. This course makes the student aware of the social, moral, ethical, and philosophical impact of computers on society and the future.

Another course, on the senior and introductory graduate level, studies the influence of computers on the humanities and the role of the humanities for computer research and applications, as well as the value considerations of computer uses.

WPI is aware of possible misuses of computers and requires that student and faculty use of computers in courses and projects adhere to the guidelines of the Committee for the Protection of Human Subjects. These guidelines cover the kinds of information stored, the security of the information, and the uses it is put to.

In addition to the computer courses provided by the Computer Science program, many other academic departments provide courses in which computer related skills are an integral part of the instruction. An example is the manual developed by A.F. Chalabi of the Civil Engineering Department, entitled "Matrix Computer Analysis of Structures" which is used in structural analysis courses. (1).

Computer Science Curricula

The Computer Science Department was established in 1968. The number of students majoring in the program has grown from about 50 in 1968, to 100 in 1972, to 200 in 1976.

The Computer Science program leads to a Bachelor of Science in Computer Science. In order to pass the competency examination, students must know how to program in several higher level languages, as well as assembler language; have a knowledge of mathematics through calculus and discrete math, and probability and statistics. They must know the fundamentals of computer architecture and operating systems, know the principals of programming and programming languages, know how to structure data as well as programs, and have a strong awareness of the social and human implications of computing.

Courses offered in the program include the following:

Introduction to Digital Computer Programming
Higher Level Languages
Assembler Language Programming
Business Data Processing I and II
Introduction to Discrete Structures
Numerical Methods
Discrete Simulation
Applied Symbolic Logic
Digital Computer Processes
Systems Programming
Operating Systems
Data Structures
Comparative Analysis of Languages
Design of Algorithmic Languages
Computer Graphics
Human Factors in Computer Based Systems
Social Implications of Information Processing

As part of the program, students are required to complete two projects, each equivalent to approximately 9 credit hours of course work. One must be in an interactive area which involves the application of the student's knowledge to a social problem. The other project must be in the student's major field of interest. An example of the latter is a project by Ronald Howard, in which he developed a compiler and operating environment for the BASIC language on the DECsystem-10. (2)

Each student, with a faculty advisor, designs a specific program of courses and projects to meet the career objectives of that student. The program prepares students for graduate school and for careers in management computing, scientific computing, and other application fields in the computer industry.

Students are strongly encouraged to carry out projects with neighboring industry, commercial institutions, local and state government, and the computer industry. These off-campus projects give students the experience of working on real problems of a major scale, of working as part of a team, and of acquiring the necessary speaking and writing skills.

A fulltime faculty of seven administers the program.

The program costs approximately $1000 per student for faculty, secretary, and departmental equipment (mini and microcomputer laboratory). The program is funded out of a school-allocated budget. Much of the equipment was donated by neighboring industry.

Outreach

The Worcester Area Computation Center shares its computer facilities with other educational institutions, provides data processing services, and provides computing facilities to continuing education courses. WPI also reaches the community through mini-courses and student projects.

FACILITIES

Both the DECsystem-10 and the UNIVAC 90/60 are used by several other institutions for academic purposes. Both are used by 3 other colleges and one high school in the Worcester area. Institutions pay for the time and facilities as used with free consultation and programming aids provided by WPI.

The computer center publishes a monthly newsletter from September through May which is distributed to all users on and off campus. (7)

The facilities at WPI are offered to all registered students including those in the continuing education (evening) programs.

DATA PROCESSING

WPI provides data processing services to area businesses as well as some twenty colleges and high schools in the New York/New England area. This academic data processing includes maintaining student records and printing reports.

COURSES

WPI runs a 2-week Intersession during January of each year consisting of four sessions of mini-courses. Course registrations are open to the public. Some of the computer related courses which have been given include Computer Networks; Computer Systems; Microprogramming; Chess and Checkers; Elements of Programming Style; ICES; Microcomputers; Statistical Packages.

STUDENT PROJECTS

Many of the undergraduate Interactive Qualifying Projects deal with practice teaching in area grammar schools and high schools. Some of these have been to teach introductory computer science and programming to high school students. The projects have involved use of the interactive capabilities of the DECsystem-10 for computer-assisted instruction and programming.

INSTRUCTIONAL MATERIALS

WPI cooperates with other institutions in the development of educational material. As part of the Experimental Program for the Reorientation of Teaching Program at Drexel, WPI helped develop self-learning material in computer programming for engineering students.

Plans and Goals

The primary goal of academic computing at WPI is to provide as much computing power to WPI students as is economically possible, and to ensure that these facilities keep up with the state of the art in computing.

With the help of the academic advisory committee, WACCC facilities are reviewed each month to ensure that goals are being met.

Lessons Learned

James J. Jackson, Jr., the Director of the Worcester Area College Computation Center offers advice on the subject of computer center management and computer use policies.

MANAGEMENT

For management of a college computer center, WPI finds that a Director should have technical knowledge in computing and management experience, rather than an academic background.

The Director should report directly to the President, and not to a financial officer. If the Director reports to a financial officer, then financial computer systems will take first priority and academic computing will be a poor second.

USE POLICIES

WPI's policy of providing unlimited computing to students has been generally successful. However, very clear rules should be established with regard to game playing, and the student population should be made to be informed as to the policies through meetings, school newspaper, and the like.

Contacts

The reader may wish to learn more about specific aspects of academic computing at WPI, by contacting members of the staff or faculty. The following individuals are most knowledgeable regarding applications and facilities in their departments:

WACCC

Director — James J. Jackson, Jr.
WACCC Department
Worcester Polytechnic Institute
Worcester, Ma. 01609
WPI Telephone — Area Code 617-753-1411, Ext. 531

COMPUTER SCIENCE DEPARTMENT

Dr. Norman Sondak, Head, Ext. 408
Prof. Stephen Alpert, Ext. 416
Prof. James Perry, Ext. 357

FACULTY DEPARTMENTS

Biomedical Engineering — Robert Peura, Ext. 447
Chemical Engineering — Imre Zwiebel, Ext. 350
Chemistry Dept. — Alfred Scala, Ext. 263
Civil Engineering — K. Keshavan, Ext. 309
Electrical Engineering — Harit Majmudar, Ext. 231
Humanities Dept. — Donald Johnson, Ext. 246
Life Sciences Dept. — James Danielli, Ext. 587
Management Engineering Dept. — Arthur Gerstenfield, Ext. 471
Mathematics Dept. — Joseph Malone, Ext. 241
Mechanical Engineering — Donald Zwiep, Ext. 221
Military Science Dept. — Lt. Col. John McDonald, Ext. 268
Physics Dept. — Robert Long, Ext. 249
Social Sciences Dept. — Leonard Goodwin, Ext. 563

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1. Chalabi, A.F. *Manual for Matrix Computer Analysis of Structures*, Study Guide and Lecture Supplements. Worcester Polytechnic Institute Civil Engineering Department, 1976.

2. Howard, Ronald A. Basic Operating System for the DECsystem-10. Major Qualifying Project, Worcester Polytechnic Institute, 1977.

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4. Rupp, Richard and Howard, Ron. Teaching at Auburn High. An Interactive Qualifying Project. Worcester Polytechnic Institute, 1976.

5. *Facility Usage Guide*, Worcester Area College Computation Center, 1977.

6. *General Operations Policy Guide*, Worcester Area College Computation Center, 1977.

7. WACCC Newsletters. Worcester Area College Computation Center, Worcester Polytechnic Institute.

8. *Timesharing Users Guide*, Worcester Area College Computation Center, 1976.

9. *UNIVAC 90/60 Batch User's Guide*, Worcester Area College Computation Center, 1977.

APPENDIX:

CASE STUDY AND EXEMPLAR INSTITUTIONS

Case Study

The following educational institutions have been selected to participate as Case Studies in Academic Computing.

The persons to contact regarding academic computing at the Case Study institutions are identified in the *Academic Computing Directory* published by HumRRO.

North Salem High School, Salem, Oregon
George Washington High School, Denver, Colorado
Lincoln High School, Bloomington, Minnesota
Ridgewood High School, Ridgewood, New Jersey
Riverdale Country School, Bronx, New York
Huntington Beach Union High School District, Huntington Beach, California
Alexis I. DuPont School District, Greenville, Delaware
Chicago Public Schools, Chicago, Illinois
Dallas Independent School District, Dallas, Texas
Lawrence Hall of Science, Berkeley, California
William Rainey Harper Community College, Palatine, Illinois
Golden West Community College, Huntington Beach, California
United States Naval Academy, Annapolis, Maryland
Worcester Polytechnic Institute, Worcester, Massachusetts
Denison University, Granville, Ohio
Evergreen State College, Olympia, Washington
Jackson State University, Jackson, Mississippi
Mankato State University, Mankato, Minnesota
Rutgers, The State University, Piscataway, New Jersey
University of Delaware, Newark, Delaware
University of Texas, Austin, Texas

Exemplar Institutions

Educational institutions identified here are participating in the study, "Exemplary Institutions in Academic Computing." These institutions have been selected as Exemplars in one or more Categories of Excellence, on the basis of written responses to a series of questionnaires prepared by the Human Resources Research Organization.

Individuals to contact regarding academic computing at the Exemplar institutions, may be found in the *Academic Computing Directory* published by HumRRO.

CATEGORY 1: STUDENT ACCOMPLISHMENTS

Colleges and Universities With Student Enrollment Over 6,000 FTE

University of California, Irvine (CA)
University of Akron (OH)
University of Pittsburgh (PA)
University of Texas, Austin (TX)

Colleges and Universities With Student Enrollment Under 6,000 FTE

University of D.C., Van Ness
Grinnell College (IO)
Transylvania University (KY)
U.S. Naval Academy (MD)
Worcester Polytechnic Institute (MA)
Bennett College (NC)
Denison University (OH)
Evergreen State College (WA)

Community Colleges

Gavilan College (CA)
Golden West College (CA)
William Rainey Harper College (IL)
Burlington County College (NJ)

Elementary and Secondary Schools

George Washington HS (CO)
Ballou HS (DC)
Hull HS (MA)
Joyner Elementary School (NC)
Amherst Central Senior HS (NY)
Riverdale Country School (NY)
Belmont HS (OH)
North Salem HS (OR)
Sehome HS (WA)

Public School Districts

Huntington Beach USD (CA)
Los Nietos ESD (CA)
Montgomery County PS (MD)
School District of Kansas City (MO)
Syosset Central SD (NY)
Woodridge PS (OH)
Memphis City Schools (TN)
Dallas ISD (TX)
Richardson ISD (TX)
Jordan SD (UT)
Fairfax PS (VA)
Highline SD (WA)

Public Access

Capital Area Career Center (MI)

CATEGORY 2: INSTITUTION ACCOMPLISHMENTS

Colleges and Universities With Student Enrollment Over 6,000 FTE

New York Institute of Technology (NY)
University of Pittsburgh (PA)
University of Texas, Austin (TX)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Trinity College (CT)
University of Tennessee, Chattanooga (TN)
Trinity University (TX)
Carnegie-Mellon (PA)

Community Colleges

Golden West College (CA)

Elementary and Secondary Schools

Ballou HS (DC)
Garden City HS (KS)
Lincoln HS (MN)

Public School Districts

Huntington Beach USD (CA)
Atlanta PS (GA)
Chicago PS (IL)
Albuquerque PS (NM)
Jamesville-DeWitt CSD (NY)

CATEGORY 3: SPECTRUM OF COMPUTER APPLICATIONS TO LEARNING AND TEACHING

Colleges and Universities with Student Enrollment Over 6,000 FTE

Auburn University (AL)
California State at Fresno (CA)
Stanford University (CA)
University of Colorado, Boulder (CO)
University of Delaware (DE)
Southern University and A&M College (LA)
Mankato State University (MN)
Rutgers University (NJ)
Ohio State University (OH)
University of Pittsburgh (PA)
University of Texas, Austin (TX)
University of Texas, El Paso (TX)
Western Washington University (WA)
University of Wisconsin, LaCrosse (WI)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Colorado School of Mines (CO)
Fairfield University (CT)
Trinity College (CT)
Anderson College (IN)
Grinnell College (IO)
Emporia State University (KS)
U.S. Naval Academy (MD)
Carleton College (MN)
Northern Montana College (MT)
Worcester Polytechnic Institute (MA)
Dartmouth College (NH)
Hamilton/Kirkland College (NY)
Bennett College (NC)
University of North Carolina, Asheville (NC)
Denison University (OH)
Bucknell University (PA)
University of Tennessee, Chattanooga (TN)
University of Tennessee, Martin (TN)
Trinity University (TX)
Evergreen State College (WA)
University Wisconsin, Superior (WI)

Community Colleges

Golden West College (CA)
William Rainey Harper College (IL)
St. Louis CC, Florissant Valley (MO)
Broome County CC (NY)
Roane State CC (TN)

Elementary and Secondary Schools

George Washington HS (CO)
Garden City HS (KS)
Lincoln HS (MN)
Maple Lake HS (MN)
Ridgewood HS (NJ)
Teaneck HS (NJ)
Commack HS South (NY)
Jericho HS (NY)
Joyner Elementary School (NC)
West Cary Jr. HS (NC)
Belmont HS (OH)
Catlin Gabel School (OR)

Public School Districts

Huntington Beach USD (CA)
Palo Alto SD (CA)
San Francisco Unified SD (CA)
Chicago Public Schools (IL)
Wichita PS (KS)
Jamesville-DeWitt CSD (NY)
Dallas ISD (TX)

CATEGORY 4: COMPUTER LITERACY PROGRAMS FOR STUDENTS, FACULTY OR COMMUNITY

Colleges and Universities With Student Enrollment Over 6,000 FTE

Auburn University (AL)
University of California, San Diego (CA)
Mankato State University (MN)
Rutgers University (NJ)
University of Illinois, Urbana (IL)
New York Institute of Technology (NY)
University of Texas, Austin (TX)
University of Texas, El Paso (TX)
University of Wisconsin, LaCrosse (WI)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Colorado School of Mines (CO)
Fairfield University (CT)
Grinnell College (IO)
U.S. Naval Academy (MD)
Carleton College (MN)
Northern Montana College (MT)
Dartmouth College (NH)
Bennett College (NC)
Denison University (OH)
Cameron University (OK)
Bucknell University (PA)
Moravian College (PA)
University of Tennessee, Chattanooga (TN)
Trinity University (TX)
Evergreen State College (WA)

Community Colleges

Gavilan College (CA)
Mercer County CC (NJ)

Elementary and Secondary Schools

George Washington HS (CO)
St. Patrick HS (IL)
Lincoln HS (MN)
Maple Lake HS (MN)
North Salem HS (OR)
Teaneck HS (NJ)
Amherst Central Senior HS (NY)
Riverdale Country School (NY)

Public School Districts

Huntington Beach USD (CA)
Palo Alto USD (CA)
San Jose USD (CA)
Alexis I. DuPont (DE)
Montgomery County PS (MD)
Albuquerque PS (NM)
N. Syracuse Central SD (NY)
Dallas ISD (TX)
Richardson ISD (TX)
Fairfax County PS (VA)
Highline SD (WA)

Public Access

Lawrence Hall of Science (CA)

CATEGORY 5: COMPUTER SCIENCE OR DATA PROCESSING CURRICULA

Colleges and Universities With Student Enrollment Over 6,000 FTE

California Polytechnic State University, San Luis Obispo (CA)
Mankato State University (MN)
Western Washington University (WA)
University of Colorado, Boulder (CO)
Rutgers University (NJ)
Ohio State University (OH)
University of Texas, Austin (TX)
University of Wisconsin, LaCrosse (WI)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Anderson College (IN)
U.S. Naval Academy (MD)
Worcester Polytechnic Institute (MA)
University of North Carolina, Wilmington (NC)
State University of New York, Plattsburgh (NY)
Bucknell University (PA)
Carnegie-Mellon (PA)

Community Colleges

William Rainey Harper College (IL)
St. Louis Community College, Florissant Valley (MO)
Burlington County College (NJ)
Mercer County College (NJ)
Roane State Community College (TN)

Elementary and Secondary Schools

George Washington HS (CO)
Ballou HS (DC)
Hull HS (MA)
Belmont HS (OH)
N. Salem HS (OR)
Ridgewood HS (NJ)
Teaneck HS (NJ)
Amsterdam HS (NY)
Commack HS South (NY)
Riverdale Country School (NY)
Sehome HS (WA)

Public School Districts

Jefferson County PS (CO)
Alexis I. DuPont SD (DE)
Atlanta PS (GA)
Chicago PS (IL)
Albuquerque PS (NM)
Churchill Area SD (PA)
Dallas ISD (TX)
Fairfax County PS (VA)

CATEGORY 6: OUTREACH TO COMMUNITY AND OTHER INSTITUTIONS

Colleges and Universities With Student Enrollment Over 6,000 FTE

California State, Fresno (CA)
University of California, Irvine (CA)
University of Illinois, Urbana (IL)
Mankato State University (MN)
Jackson State University (MS)
University of North Dakota (ND)
University of Akron (OH)
Ohio State University (OH)
University of Pittsburgh (PA)
University of Texas, Austin (TX)
Western Washington University (WA)
University of Wisconsin, LaCrosse (WI)

Colleges and Universities With Student Enrollment Under 6,000 FTE

Fairfield University (CT)
Lewis University (IL)
Grinnell College (IO)
U.S. Naval Academy (MD)
Worcester Polytechnic Institute (MA)
Northern Montana College (MT)
Dartmouth College (NH)
University of North Carolina, Asheville (NC)
Denison University (OH)
Bucknell University (PA)
University of Tennessee, Chattanooga (TN)
Rice University (TX)
Evergreen State College (WA)

Community Colleges

Maricopa Community College District (AZ)
Gavilan College (CA)
Golden West College (CA)
Burlington County College (NJ)
Mercer County Community College (NJ)
Roane State Community College (TN)

Elementary and Secondary Schools

George Washington HS (CO)
Canterbury School (CT)
Ballou HS (DC)
St. Patrick HS (IL)
Hull HS (MA)
Ridgewood HS (NJ)
Riverdale Country School (NY)
Belmont HS (OH)
Catlin Gabel (OR)
Upper St. Clair HS (PA)
Sehome HS (WA)

Public School Districts

Huntington Beach USD (CA)
Los Nietos ESD (CA)
San Francisco Unified SD (CA)
Jefferson County PS (CO)
Alexia I. DuPont SD (DE)
School District of Kansas City (MO)
Wayne Township PSD (NJ)
Jamesville-DeWitt CSD (NY)
Churchill Area SD (PA)
Dallas ISD (TX)
Fairfax County PS (VA)

Public Access

Lawrence Hall of Science (CA)
Capital Area Career Center (MI)